Paleohydrological and limnological signatures in small karstic lakes based on XRF analyses: La Parra Lake (Cuenca, Spain)

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INTRODUCTION

Our aim is to investigate the hydrological and geochemical response of La Parra karstic lake to anthropogenic and climate forcings for the last 4000 years.

To achieve these goals we use a multidisciplinary approach to study the modern and past depositional processes at watershed and lake scales, and to evaluate their interactions with various environmental controls (climate and human impact) at different time scales.

XRF core scanner analyses on lake sediments have provided high resolution reconstructions of past global and climate changes (Richter et al. 2006; Saez et al., 2009). Several examples of Spanish karstic lakes have been recently published - Laguna Taravilla (Moreno et al., 2008), Laguna Estanya (Morellón et al., 2008) Lago Montcortès (Corella et al., in press)

In this contribution we show the preliminary results of La Parra Lake sequence, and the use of the XRF core scanner dataset to better understand a number of sedimentological processes:

- **Clastic input:** Human impact in the watershed during the last millennia has provoked an increase in sediment delivery to many lakes in Spain. Increase run-off cause by climate factors can also be identified as short-term flooding events. Detailed XRF data may serve to differentiate both scenarios.

- **Carbonate deposition in karstic lakes:** The carbonate bedrock makes more difficult to isolate carbonate formation within the lake. We use Sr/Ca ratio in order to distinguish between endogenic and allocthonous carbonates since Sr is usually higher in lacustrine carbonates formed under relatively higher chemical concentration (magnesium-rich calcite and aragonite). However the presence of dolomite in the watershed may pose a problem to this approach.

- **Evolution of redox stages at the lake bottom:** Fe/Mn, Fe/S and Fe/Ti ratios can be used to unravel the evolution of the pH/Eh conditions during the sedimentation and early diagenesis stages.

- **Primary productivity:** Some XRF scanners provide the incoherent (Compton)/coherent (Raleigh) ratio that can be used as an indicator of the organic matter, when the organic content of the sediments is high (Sáez et al., 2009). Since those values are not available and the phosphorous cps are lo, we have tried the Si/Ti ratio to distinguish biogenic from the siliciclastic silica. The approach has to be tested with biogenic silica analyses.

GEOGRAPHICAL SETTING

- Lake La Parra is a circular sinkhole, of 17.5m depth and 111-116m diameter, located on a karstic massif at 1000masl. in the Iberian Range (UTM30596745, 4426442; Iberian Peninsula).

- The lake is a doline formed in Cretaceous dolomites that sub-horizontally overlie impermeable Middle-Upper-Cenomanian green clay-marls.

- The regional climate is Mediterranean and the hydrology is controlled by groundwater sources with limited surface runoff.

- Recently the lake has underwent significant lake level fluctuations in response to changing aquifer fluxes, mainly due to agricultural extraction wells around the area.

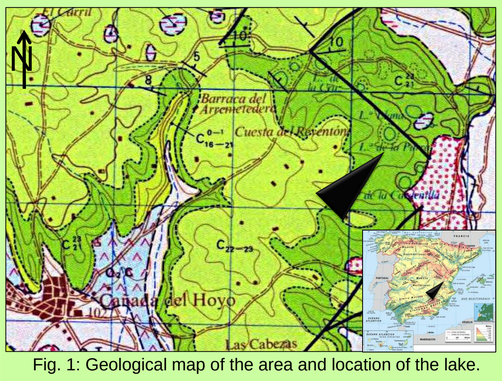


Fig. 1: Geological map of the area and location of the lake.

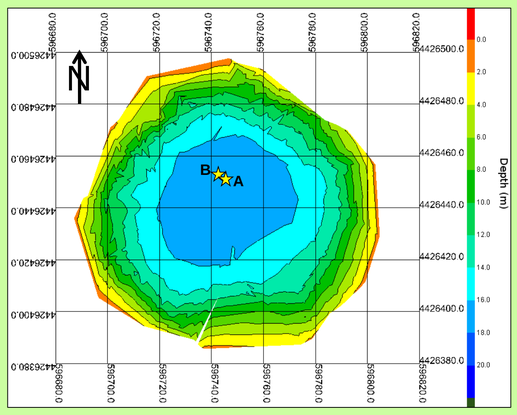


Fig. 2: Location of cores A & B and lake's bathymetry obtained by an SonarMite © echosounder.

MATERIAL AND METHODS:

In May 2010, two long cores (up to 6.93m (A) and 5,24m (B) long) were recovered from La Parra Lake using the UWITEC © corer and the UWITEC © platform raft (sections PA10-1A-1U-1 to PA10-1A-1U-5 and cores PA10-1B-1U-1 to PA10-1B-1U-4).

Fig. 3: UWITEC platform raft waiting for action.

The sections were split longitudinally and imaged using the CCD camera attached to the XRF core scanner.

XRF (X-Ray Fluorescence) analyses were performed using the Avaatech © core scanner from the Marine Geosciences Department, Faculty of Geology, University of Barcelona (UB). The sampling interval was of 5 mm.

All sections were measured at 10 kV (30s) and 30kV (15 s) X-tube voltages in order to determine the maximum possible chemical elements and to obtain statistically significant counts. The identified chemical elements were:

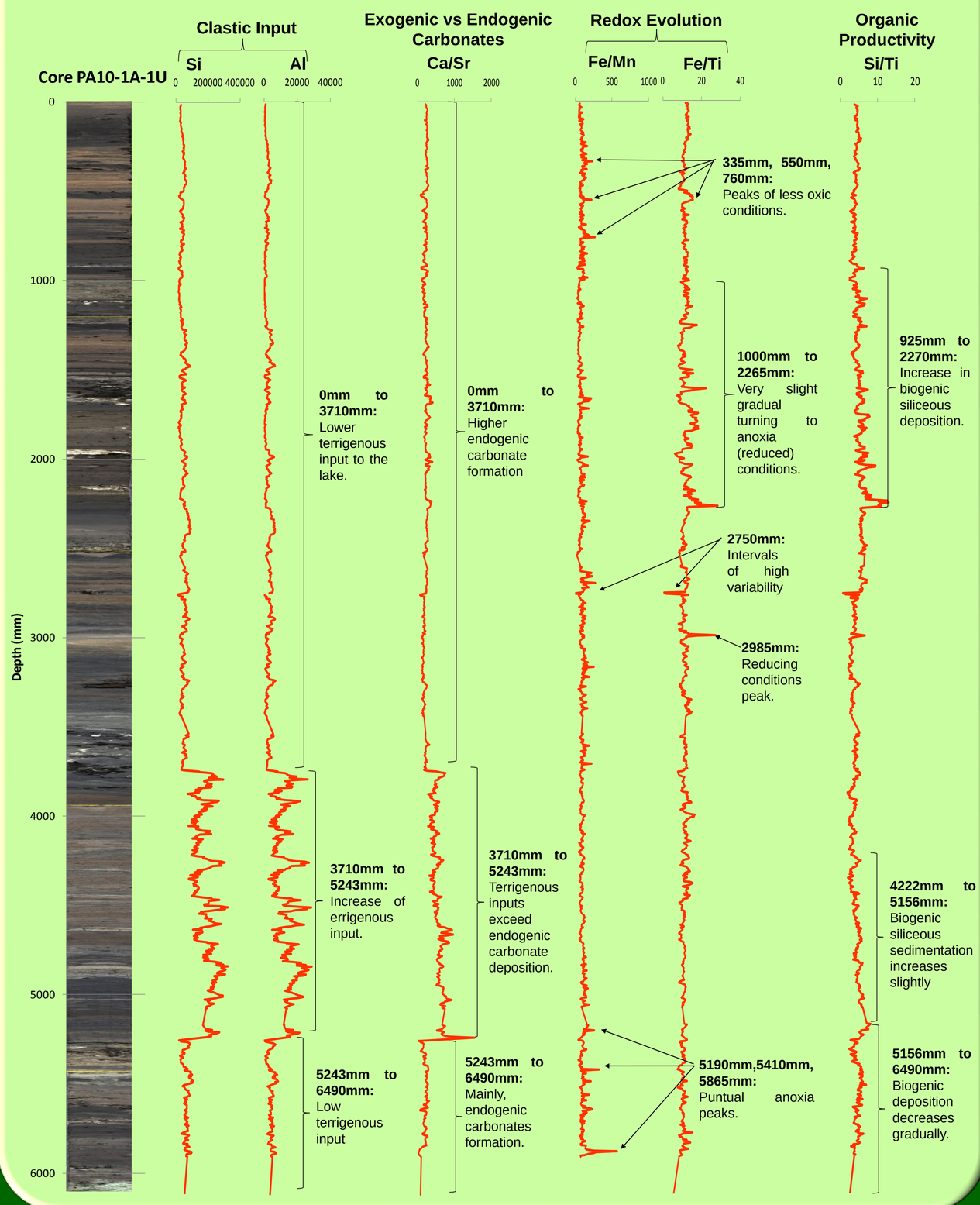
- Al, Si, P, S, Cl, K, Ca, Ti, V, Cr, Mn, Fe (10kV)
- Ni, Cu, Zn, Ga, Ge, As, Br, Rb, Sr, Y, Zr, Pb (30kV)

Fig. 4: XRF Core Scanner at the Marine Geosciences Department, University of Barcelona.

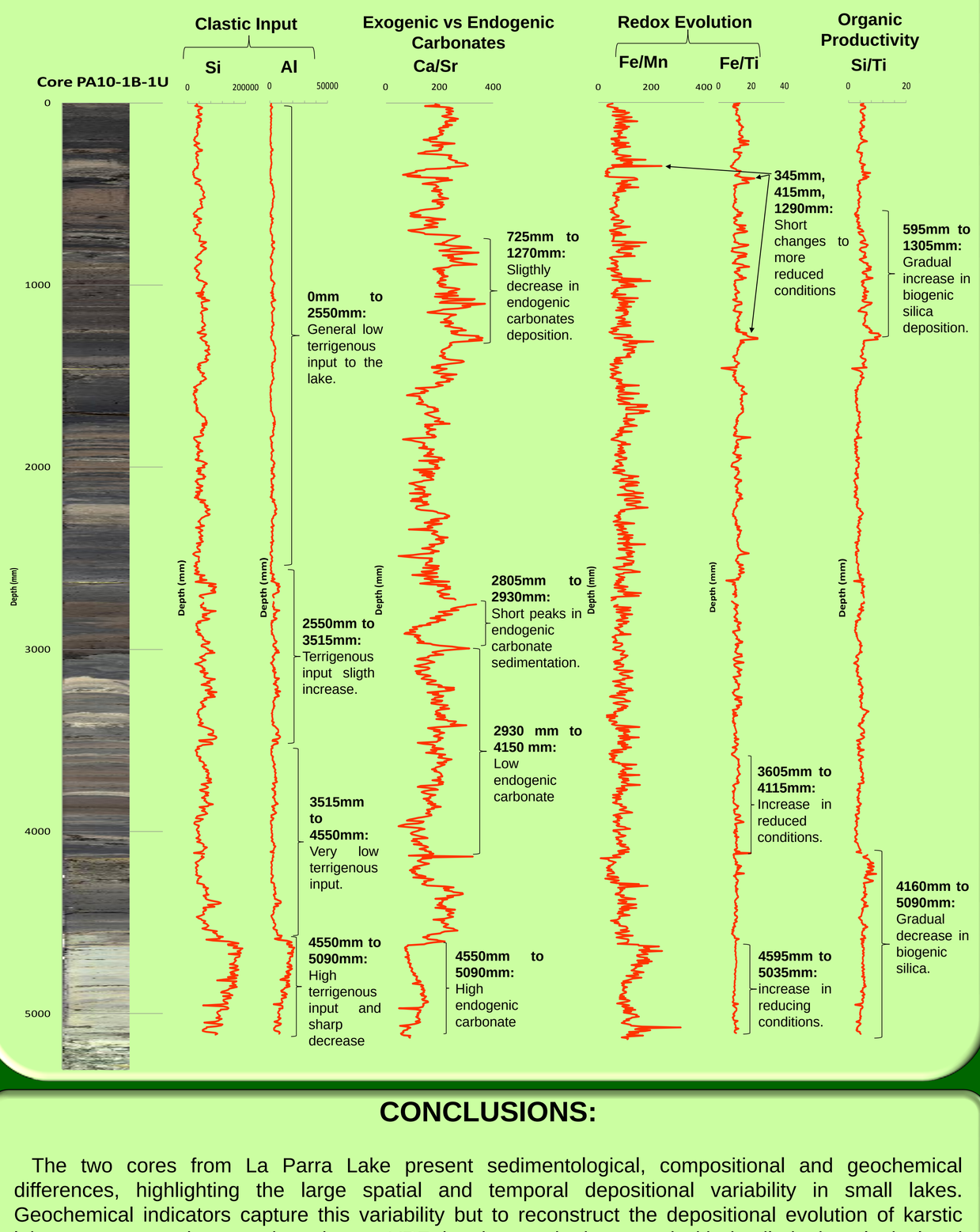
RESULTS

The La Parra lake sediments are mainly composed by carbonates (calcite and dolomite), quartz, clay minerals, Fe-oxides and organic matter arranged in light greyish brown 1,5-2cm bands and <0,5cm laminae. Some macro-plant remains have been found and ^{14}C AMS dating is in progress. Other compositional (total carbon and total nitrogen and mineralogical (XRD) analyses are also in progress.

CORE PA10-1A-1U



CORE PA10-1B-1U



CONCLUSIONS:

The two cores from La Parra Lake present sedimentological, compositional and geochemical differences, highlighting the large spatial and temporal depositional variability in small lakes. Geochemical indicators capture this variability but to reconstruct the depositional evolution of karstic lake processes and test our hypotheses, XRF data have to be integrated with detailed mineralogical and sedimentological facies analyses.

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